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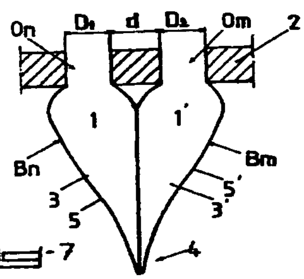
Processes for producing multi-segmented surfaces or fibers as well threads or fibers and textile surfaces resulting therefrom



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The object of the present invention is a process for producing multi-segmented threads or fibers and/or compound structures, as well as threads or fibers and textile surfaces obtained thereby.

Process characterized by the fact that it consists of guiding the polymeric material or the polymeric materials (1, 1') into a spinneret (2) under suitable rheological conditions, then extruding this polymer or these polymers through spinning or extruding apertures (O_n, O_m), which are separated from each other, but which are arranged in a group or in several groups so as to form a set or several sets of at least two elementary threads (3, 3'), and then, via adhesive contact, joining the different elementary threads (3, 3') emerging from each group (G) of apertures (O_n, O_m) into a thread (4) with a multi-segmented cross-section per group, with limited or non-existent phase mixing, and finally consolidating and stretching the resulting threads before they are directly supplied to subsequent processing and/or treatments, in particular for the purpose of producing e.g. fibers, spooled threads, cables or non-woven fleeces.

Description

[0001] The present invention belongs to the field of textile products and their applications, in particular to the field of woven, knitted or non-woven textile surfaces, and its object is a production process for a multi-segmented thread or a multi-segmented fiber, a thread or a fiber, which is obtained in this manner as well as textile surface formed of such threads or fibers.

[0002] Numerous processes for the production of multi-segmented threads or fibers as well as non-woven textile surfaces are presently known, which are ultimately due to the production of elementary threads of very low titer via an adapted separation technology. These multi-segmented threads or fibers are at present produced in the form of mono-threads or mono-fibers, by coextruding one or more thermoplastic or polymeric materials or polymeric materials dissolved in a specific solvent through spinneret openings that are partitioned or supplied with different polymers and that are configured depending on the segmentation and the desired elementary thread shapes.

[0003] However, this coextrusion method brings with it a certain number of restrictions and disadvantages.

[0004] Thus, the separation of the multi-segmented threads into elementary threads is frequently difficult to accomplish and it requires devices, which develop substantial separation forces, particularly in the context of a mechanical separation.

[0005] In addition, this separation is at present nearly impossible to accomplish if the threads or fibers consist of elementary threads or fibers consisting of chemically compatible polymers or of the same polymer.

[0006] This difficulty in accomplishing the separation into elementary threads is in particular attributable to the phase mixture formed between the different elementary threads, since they are joined while the constitutive polymers are still in a mixable state.

[0007] In addition, the variety of shapes and titers producible with the help of the present technology is limited due to the necessary complexity of the supply circuits, the low boundary conditions in spinning and extruding threads or fibers with fine titers, physical impossibilities due to coextrusion and operational difficulties, as well as the exorbitant costs of the necessary spinnerets.

[0008] Furthermore, it is not possible with the help of the present technology to obtain complex external shapes with clear outlines such as edges, denticulations or the like, since these latter flow due to the rheological properties of the polymers in the molten state or in the form of solutions.

[0009] The present invention seeks in particular to remedy the aforementioned disadvantages.

[0010] For this purpose it concerns a process for producing multi-segmented threads or fibers and/or compound structures, in particular for textile surfaces, by extruding or spinning thermoplastic polymers or polymer solutions, which process is characterized by the fact that it consists of guiding the polymeric material or the polymeric materials into a spinneret under suitable rheological conditions, then extruding this polymer or these polymers through spinning or extruding apertures, which are separated but are arranged in a group or in several groups so as to form a set or several sets of at least two elementary threads, and then, via adhesive contact, joining the different elementary threads emerging from each group of openings into a single thread with a multi-segmented cross section per group, with limited or non-existent phase mixing, and finally consolidating and stretching the resulting threads, before they are directly supplied to subsequent processing and/or treatments, in particular for the purpose of producing e.g. fibers, spooled threads, cables or non-woven fleeces.

[0011] This invention will be better understood owing to the subsequent description, which refers to the preferred processing methods, which are provided as examples and are not to be regarded as exclusive, and which are described with reference to the attached schematic drawings.

[0012] Among these the drawings, Figs. 1 – 6 are top views of five variants of embodiments of spinneret plates of this invention.

[0013] Fig. 7 is a lateral view of a partial section of a part of a spinneret of this invention, which is used in the context of the production process of this invention.

[0014] Fig. 8 is a top view of the part of the spinneret represented in Fig. 7.

[0015] Fig. 9 is a lateral view of a partial section of a part of a spinneret used within the scope of the present invention according to a variant of an embodiment of this invention.

[0016] According to this invention, the process for the production of multi-segmented threads or fibers and/or compound structures, in particular for textile surfaces, consists of guiding the polymeric material or the polymeric materials 1,1' into a spinneret 2 under suitable rheological conditions, then extruding this polymer or these polymers through spinning or extruding apertures O_n,O_m, which are separated from each other but are arranged in a group or in several groups G, in order to form a set or several sets of at least two elementary threads 3, 3', and then, via adhesive contact, joining these different elementary threads 3, 3' emerging from the groups G of openings O_n, O_m, into a single thread with a multi-segmented cross section per group, with limited or non-existent phase mixing, and finally consolidating and stretching the resulting threads 4, before they are directly supplied to subsequent processing and/or treatments, in particular for the purpose of producing e.g. fibers, spooled threads, cables or non-woven fleeces.

[0017] Thus, in contrast to the coextrusion technology of the current state of the art, in which the phases of the different components come into contact with one another in the single spinning aperture for each multi-segmented thread or multi-segmented fiber while the phases are still mixable, this invention causes an extrusion through nozzle exits O_n, O_m that are independent of each other and establishes contact between the components emerging from these apertures, which form the different elementary threads 3, 3 ', outside of the nozzle exits O_n,O_m, while skins 5, 5 ' have already come into existence, which bound the phases of said components, and which cause the viscosities of the latter to differ significantly from what they were in the region of the nozzle exits O_n, O_m.

[0018] One thus arrives at a multi-segmented thread or to a multi-segmented fiber 4, whose coherence is due to adhesive contact between the boundary surface zones of the different components, which are still sufficiently plastic and adherent to produce an adhesive surface bond, but which are, at the same time, sufficiently solidified to clearly avoid any phase mixing in the region of the contacting surfaces.

[0019] The binding forces between the different elementary threads or fibers 3, 3' will thus be sufficient to maintain the uniform structure of the multi-segmented threads or fibers 4 in the course of possible later processing or treatment steps

(where the multi-segmented threads or fibers naturally exhibit a higher strength than the various elementary threads taken separately), but will nevertheless have a limited magnitude, so that their later separation, particularly by mechanical means, is favored.

[0020] The nozzle exits O_n, O_m, which supply the elementary threads 3, 3', generally consist of mouthpieces with a simple opening (fully walled opening), which is not partitioned and segmented, which facilitates the spinning operation.

[0021] However, depending on the desired type of thread or fiber and the textile surface resulting therefrom, one or more of these nozzle exits O_n, O_m, can exhibit segmentation or partitioning, in particular partitioning into two compartments, e.g. for the production of bi-lamellar fibers.

[0022] According to a first characteristic of this invention, which is in particular represented in Figs. 7 and 9 of the attached drawings, the nozzle exits O_n, O_m, of same group G are arranged with respect to each other such that the bulge B_n or B_m of polymeric material, which is formed in the extrusion process at the exit of each nozzle exit O_n, O_m, is in contact with at least one bulge B_n or B_m, which is formed at the exit of at least another nozzle exit O_n, O_m, of the same group G.

[0023] The formation and dimensions of the bulges B_n, B_m, which are formed at the outlet of the nozzle exits and from which the elementary threads 3, 3' are drawn by stretching, are determined by the shape and size of the nozzle exits, by the nature of the extruded polymer or the extruded polymers or polymer solution(s), as well as by the pressure, the speed and the rheological conditions in the extrusion and spinning operations and the solidification conditions.

[0024] The latter parameters therefore also make it possible to affect the binding forces between the different elementary threads 3 3'.

[0025] According to a favorable embodiment of this invention, each nozzle exit of a group G of nozzle exits O_n, O_m, with round or evident circular cross sections tests for the following relationship (1) toward at least one other nozzle exit O_m of the group G:

$$0.5 \times (D_n+D_m)/2 \leq d \leq 5 \times (D_n+D_m)/2, \qquad (1)$$

where n is not equal to m, n varies from 1 to T and m varies from 1 to T, where T is the total number of nozzle exits of the group G, D_n is the diameter of the nozzle exit O_n, D_m of the diameter of the nozzle exit O_m and d is the distance between the closest points O_n' and O_m', on the margins of the two nozzle exits O_n, O_m (see Fig. 8 of the attached drawings).

[0026] Each nozzle exit O_n of a group G of nozzle exits O_n, O_m preferably tests for the following relationship (2) toward at least one other nozzle exit O_m of the same group G:

$$0.5 \times (D_n + Dm)/2 \leq d \leq 2 \times (D_n + D_m)/2. \qquad (2).$$

[0027] However, the shape and dimensions of the cross sections and their arrangements in relation to the nozzle exits O_n, O_m of the same group G can be determined based on the dimensions, the configuration and the desired resulting characteristics of the multi-segmented thread and/or laminate 4, where the only condition which is to be tested is that that each elementary thread 3, 3' comes into adhesive contact with at least one other elementary thread 3', 3.

[0028] Thus it is easily possible owing to this invention to obtain complex and wound external shapes of the multi-segmented threads 4, where spinneret plates 2 are used, which are provided with nozzle exits O_n, O_m of a form which can be industrially produced more simply and easily.

[0029] Likewise, because of the bonding of the elementary threads 3, 3' after the formation of the outer skins 5, 5', the contour details of the aforementioned different elementary threads or fibers 3, 3' having simple shapes, which are associated with one another in order to form a thread or a fiber 4 with a complex cross section, will not have a tendency to flow, but rather to retain a distinct definition, which corresponds to the shape of the corresponding nozzle exits O_n, O_m, whereby a distinct cross-sectional shape of the thread or the fiber 4 is obtained after cooling, even in the case of a cross section having a very complex configuration.

[0030] According to another characteristic of this invention it is, for purposes of adjusting the cohesive forces of the multi-segmented thread 4, also possible to cause the adhesive contact between at least two elementary threads 3, 3 ', which emerge from neighboring nozzle exits O_n, O_m of the same group a G, to be unequal in a continuous or interrupted manner.

[0031] It is thus possible, as Fig. 9 of the attached drawings shows, to modify the shape of the bulge B_n, B_m of polymeric material, which is formed during the extrusion process on exiting from each of the nozzle apertures O_n, O_m, at least at one of the nozzle exits O_n of a group G, within the region of its potential contact zone with the bulge or the bulges B_m, formed on exiting from at least one neighboring nozzle aperture O_m of the same group G, in order to change or decrease the adhesive contact between the two resulting elementary threads 3, 3'.

[0032] A gas strip or the use of a plate or an acute point between the corresponding openings O_n and O_m can be provided in order to implement the aforementioned process.

[0033] Depending on the desired characteristics and the nature of the resulting non-woven fleece, the nozzle exits O_n, O_m of the same group G can naturally be supplied with either the same polymeric material 1 or with at least two different polymeric materials 1, 1'.

[0034] As Figs. 1 to 9 of the attached drawings show, the present invention also has a nozzle plate 2 for applying the aforementioned production process to its object, which is characterized by the fact that it comprises numerous nozzle exits O_n, O_m, which are arranged in one or more groups G, where each nozzle exit of a group G of nozzle exits O_n, O_m with a preferably round or evident approximately round cross section tests for the aforementioned relationship (1) or preferably the aforementioned relationship (2) toward at least one other nozzle exit O_m the same group G.

[0035] The production process of this invention thus makes it possible to obtain a multi-segmented thread or a multi-segmented fiber that consists of several elementary threads or fibers (3, 3'), which are bound to each other, two with at least two, with pre-determined binding forces, through adhesive contacts along their length in the region of their skins (5, 5'), without mixing of the respective phases or with limited phase mixing.

[0036] The shapes of the spinneret plates shown in Figs. 1 - 6 of the attached drawings make it possible to show the possibilities of producing the multi-segmented threads 4 by the production process of this invention by means of examples that are not to be regarded as exclusive.
[0037] It is thus possible to produce a three-lobed thread 4 with the spinneret plate of Fig. 1, with that of Figs. 2A and 2B a thread 4 in the form of a strip or a film which can be sectioned lengthwise, with that of Fig. 3 a thread 4 in form of a daisy, with that of Fig. 4 a thread in the form of a hollow tube, with that of Fig. 5 a thread 4 of the bilamellar type (in which the two elementary threads 3 and 3 ' can be made of the same polymer or of two different polymers) and with that of Fig. 6 a thread 4, in which two hollow tubes having different diameters and made of elementary threads 3,3' having different titers cross each other.
[0038] It was determined that the structure of the thread 4 produced with the spinneret plate 2 of Fig. 3 makes it possible to e.g. produce elementary threads 3' made of a polymer which is difficult to extrude and/or to process, in that one makes use of a central elementary thread 3 as a guide thread, which is produced from an easily extrudable polymer and which can withstand subsequent processing without damage.
[0039] Lastly, the present invention also concerns a textiles fleece, in particular a non-woven fleece produced in a direct manner, which is characterized by the fact that it is at least partly produced of multi-segmented threads 4 obtained by the aforementioned production process
[0040] According to a characteristic of this invention this fleece is advantageously subjected to at least one treatment after it is produced, which treatment is intended to at least partly, preferably entirely split and separate the multi-segmented threads 4 into elementary threads 3, 3', particularly by mechanical or hydraulic means.
[0041] Two examples, which are not exhaustive, are described in the following to better illustrate this invention:

Example 1:

[0042] A fleece of bisegmented endless fibers with a surface mass of 110 g/m^2 (NFG 38013) is produced by a process, which resembles that described in the French patent no. 7420254.
[0043] The configuration of the threads forming the surface is based on a bilamellar fiber of 100 % PES with a titer of 1.2 dTex before splitting (Fig. 10: cross sectional view of these threads).
[0044] The polymer (POLYESTER) being used has the following characteristics:

Material	Polyethylene terephthalate
TiO_2	0.4 %
Melting point	256°C
Viscosity in the melted state	210 Pa at 290°C
Type and origin	Type 20 of the Hoechst Company

Spinning extrusion conditions:

[0045] The drying is performed in dry air with a dew point of -40°C and a dwell time of 3 hours at 170°C, and the extruder feed occurs in nitrogen-containing air.
[0046] The spinning unit is circular and is provided with a spinneret plate consisting of 240 groups of two capillaries (nozzle exits) lying 0.15 mm apart, with a diameter of 0.2 mm and a height of 0.4 mm.
[0047] The melt extrusion temperature of the polymer is 295°C, the spinning speed is about 4000 m/min and the output per group amounts to 0.5 g/min (0.25 g/min/capillary).

Solidification bond:

[0048] The resulting surface is (four times) subjected to hydraulic bonding with 225 bar jets (2 times per side) with a speed of 35 m/min, for which 130 micron spray nozzles are used. The initial 1.2 dTex threads are split into two identical 0.6 dTex parts.

Characteristic properties of the threads:	
Titer (DIN 53812)	1.2 dTex
Strength	27 N/CTex
Elongation	78 %

Characteristic properties of the product:			
Dynamometry	Load	SL 350 N/5cm	Algt SL 56
	Load	ST 300 N/5cm	Algt ST 62 %
	Tensile strength (NFG07146)	SL 35 N	ST 55N

Example 2:

[0049] A fleece of endless fibers with a surface mass of 130 g/m^2 is produced.

[0050] The configuration of the threads forming the surface is based on a three-lobed distribution emerging from three capillaries, which belong to the same group (Fig. 11: cross sectional view of these threads). The three capillaries of the same feed nozzle are arranged on the apexes of an equilateral triangle with a side length of 0.4 mm, the diameter of a capillary amounts to d = 0.25 mm, their height is 2 d, the distance between 2 capillaries was measured to be 0.15 mm.
[0051] The polymer and the extruding/spinning conditions are identical to those of example 1.
[0052] The output per group amounts to 0.66 g/min (3 x 0.22 g) and the speed of spinning/stretching operation amounts to about 4500 m/min, whereby a thread of 1.5 dTex is produced.

Consolidation - fixing:

[0053] The surface is subjected to double-sided needling at 200 perforations per cm^2 using needles with a fineness of 40 RB, which penetrate to 12 mm.

Characteristic properties of the threads:		Characteristic properties of the product:		
Titer	1.5 dTex	Load	SL 490 N/5cm	ST 370 N/5cm
Strength	3 IcN/Tex	Elongation	SL 60 %	ST 70 %
Elongation	78 %			

Final processing - Application

[0054] The product is then impregnated with the help of a styrene-butadiene resin with a coating weight of 480 g/m^2 and then calendared (calibrated). The final product is intended as a reinforcement for shoes.
[0055] Although the invention was described more exactly regarding the hot extrusion of polymers in the molten state, is it also applicable to dry spinning processes [solvents + polymer(s): extrusion with evaporation of the solvent] as well as for wet spinning processes [solvent + polymer(s) with nozzle exit into a dissolving bath of the solvent].
[0056] The invention is naturally not limited to the embodiments described above and represented by the attached drawings. Modifications are possible, particularly regarding the condition of the different elements or replacement with equivalent methods, without thereby departing fro the scope of inventive protection.

Claims

1. Process the production of multi-segmented threads or fibers and/or compound structures, in particular for textile surfaces, by extrusion or spinning of thermoplastic polymers or polymer solutions characterized in that it consists of guiding the polymeric material or the polymeric materials (1, 1') into a spinneret (2) under suitable rheological conditions, then extruding this polymer or these polymers through spinning or extruding apertures (O_n, O_m), which are separated from each other, but are arranged in a group or in several groups (G), so as to form a set or several sets of at least two elementary threads (3, 3'), and then, via adhesive contact, joining the different elementary threads (3, 3') emerging from each group (G) of apertures (O_n, O_m) into a tread (4) with a multi-segmented cross section per group (G), with limited or non-existent phase mixing, and to finally consolidate and stretch the resulting threads (4), before they are subjected to subsequent processing and/or treatments, in particular for the purpose of directly producing e.g. fibers, spooled threads, cables or non-woven fleeces.

2. Production process according claim 1, characterized by the fact that the spinning apertures (O_n, O_m) are arranged with respect to one another within the same group (G) so that the bulge (Bn or B_m) of polymeric material, which is formed in the extrusion process on leaving each of these nozzle exits (O_n, O_m), is in contact with at least one bulge (B_n or B_m), which is formed on leaving at least one other nozzle exit (O_n, O_m) of the same group (G).

3. Production process according to any of the claims 1 and 2, characterized by the fact that each nozzle exit (O_n) of a group (G) of nozzle exits (O_n, O_m) with round or evidently circular cross sections tests for the following relationship toward at least one other nozzle exit (O_m) of the same group (G):

$$0.5 \times (D_n+D_m)/2 \leq d \leq 5 \times (D_n+D_m)/2,$$

where n is not equal to m, n varies from 1 to T and m varies from 1 to T, where T is the total number of the nozzle exits of the group (G), D_n is the diameter of the nozzle exit (O_n), D_m of the diameter of the nozzle exit (O_m) and d is the closest distance between the points (O_n' and O_m') on the margins of the two nozzle exits (O_n and O_m).

4. Production process according to claim 3, characterized by the fact that each nozzle exit (O_n) of a group (G) of nozzle exits (O_n, O_m) tests for the following relationship toward at least one other nozzle exit (O_m) of the same group (G):

$$0.5 \times (D_n + D_m)/2 \leq d \leq 2 \times (D_n + D_m)(2.$$

5. Production process according to any of the claims 1 to 4, characterized by the fact that the shape and the dimensions of the cross sections and their arrangements in relation to the nozzle exits (O_n, O_m) of the same group (G) are determined by the dimensions, the configuration and desired properties of the multi-segmented thread and/or the laminate 4 resulting therefrom.

6. Production process according to any of the claims 1 to 5, characterized by the fact that the nozzle exits (O_n, O_m) of the same group (G) are supplied with the same polymeric material (1).

7. Production process according to any of the claims 1 to 5, characterized by the fact that the nozzle exits (O_n, O_m) of the same group (G) are supplied with at least two different polymeric materials (1, 1').

8. Production process according to any of the claims 1 to 7, characterized by the fact that the adhesive contact between at least two elementary threads (3, 3'), which emerge in a continuous or interrupted manner from neighboring nozzle exits (O_n, O_m) of the same group (G), are unequal.

9. Production process according to claim 8, characterized by the fact that the shape of the bulge (B_n, B_m) of polymeric material, which is formed on leaving each nozzle aperture (O_n, O_m) during the extrusion, is altered at least at one of the nozzle exits (O_n) of a group (G) in the region of its potential contact with the bulge or the bulges (B_m), which is (are) formed on exiting from at least one neighboring nozzle aperture (O_m) of the same group (G), in order to modify or lessen the adhesive contact between the two resulting elementary threads 3, 3 '.

10. Spinneret plate for application in the production process according to any of the claims 1 to 9, characterized by the fact that it comprises numerous nozzle exits (O_n, O_m), which are arranged in one or more groups (G), where each nozzle exit (O_n) of a group (G) of nozzle exits (O_n, O_m) with round or evidently circular cross sections, tests for the following relationship toward at least one nozzle exit (O_m) of the same group (G):

$$0.5 \times (D_n+D_m)/2 \leq d \leq 5 \times (D_n+D_m)/2,$$

where n and m are not equal, n varies from 1 to T and m varies from 1 to T, where T is the total number of nozzle exits of the grouping (G), D_n is the diameter of the nozzle exit (O_n), D_m is the diameters of the nozzle exit (O_m) and d is the distance between closest points (O_n', O_m') on the margins of the two nozzle exits (O_n and O_m).

11. Injector plate according to claim 10, characterized by the fact that each nozzle exit (O_n) of a group (G) of nozzle exits (O_n, O_m) tests for the following relationship toward at least one other nozzle exit (O_m) of the same group (G):

$$0.5 \times (D_n+D_m)/2 \leq d \leq 2 \times (D_n+D_m)/2.$$

12. Multi-segmented thread or multi-segmented fiber obtained by means of the production process according to any of the claims 1 to 9 and consisting of several elementary threads or fibers (3, 3'), which are bound to each other, at least two with two others, via adhesive contact along their length, in the region of their skins (5, 5'), without mixing of the respective phases or with limited mixing of the phases.

13. Textiles, in particular non-woven fleece, characterized by the fact that it is at least partly produced using multi-segmented threads (4) obtained by means of the production process according to any of the claims 1 to 9.

14. Textiles, in particular non-woven fleece according to claim 13, characterized by the fact, that after ii is produced, it is subjected to a treatment, which aims to at least partly, preferably completely split the multi-segmented threads (4) into elementary threads (3, 3 ') by physical or chemical means.

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Fig-1

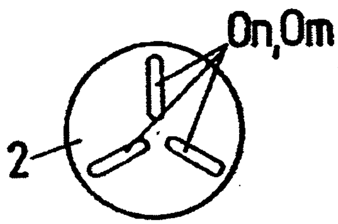


Fig-2

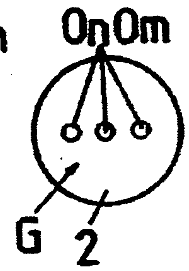


Fig-3

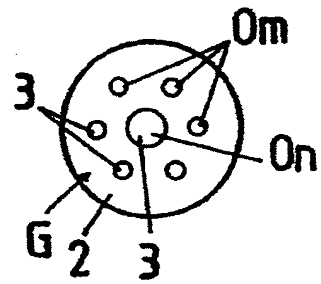


Fig-4

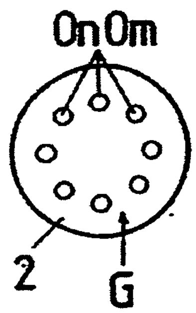


Fig-5

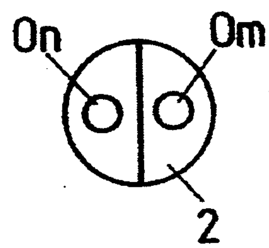
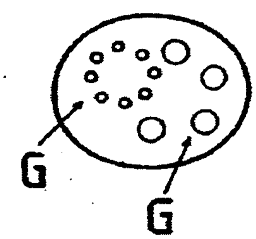


Fig-6



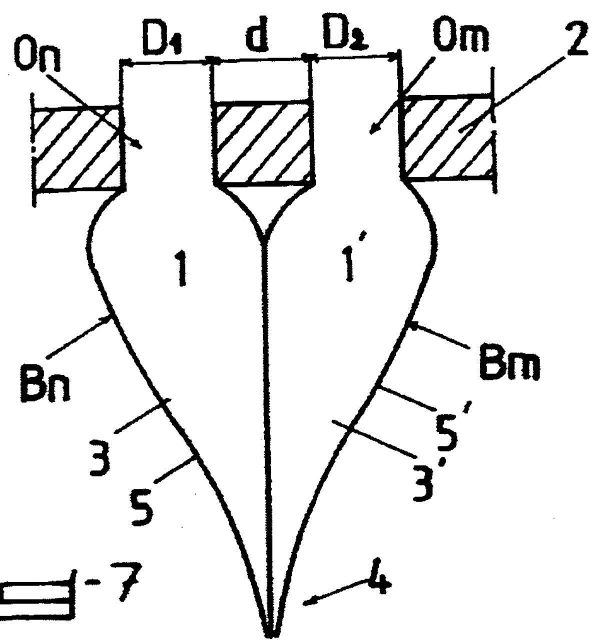


Fig-7

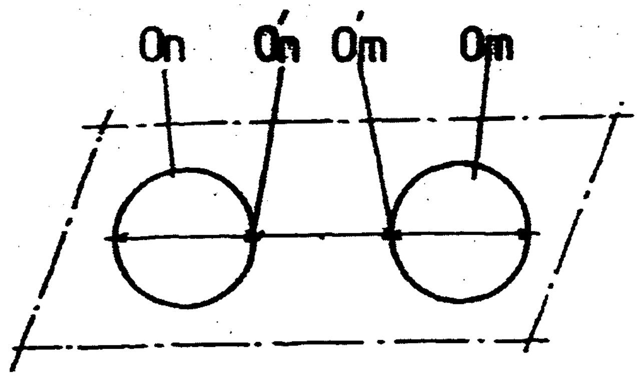


Fig-8

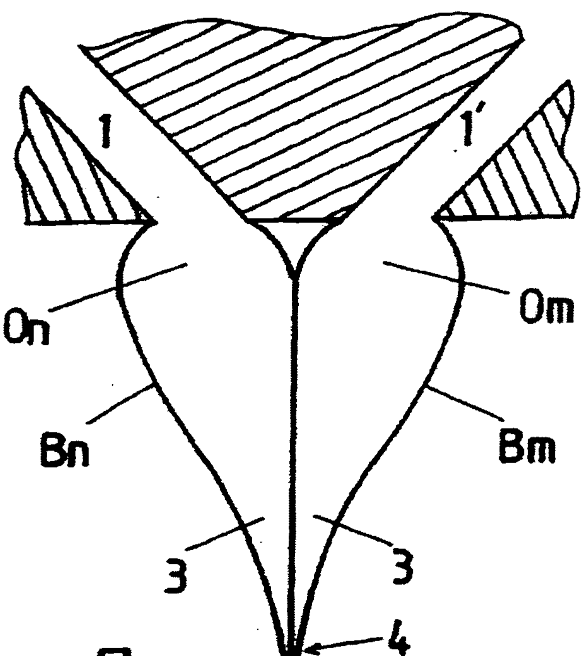


Fig-9

Fig-10

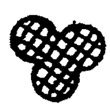


Fig-11

EUROPEAN SEARCH REPORT

Application No.
EP 00 10 3290

APPLICABLE DOCUMENTS

Category	Citation of the document with indication, as necessary, of the pertinent parts	Concerns Claim	Classification of the Application (Int. Cl. 7)
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ATTACHMENT TO THE EUROPEAN SEARCH REPORT REGARDING THE EUROPEAN PATENT APPLICATION

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This attachment lists the members of the patent families in the European Search Report named above.
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